



A
FAMILIAR INTRODUCTION
TO THE STUDY OF
ELECTRICITY.



In the Press, and speedily will be Published,

A
FAMILIAR INTRODUCTION
TO THE
THEORY and PRACTICE
OF
P E R S P E C T I V E.

By JOSEPH PRIESTLEY, L. L. D, F. R. S.

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THE SECOND EDITION.

Nunc opus est leviorē lyra.

OVID.

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1. FAMILIAR INTRODUCTION

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THE
P R E F A C E

WHEN I wrote *the History and present State of Electricity*, I flattered myself, that I had sufficiently adapted it to the use of every class of readers. My principal design was to promote discoveries in the science, by exhibiting a distinct view of the progress that had been made in it hitherto, and suggesting the best hints that I could for continuing and accelerating that progress: but I thought that the same treatise might also be perfectly intelligible
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to beginners. It seems, however, that I was mistaken in that expectation. Several persons, on whom the experiment has been tried, have declared, that they thought it not sufficiently intelligible to those who had no previous knowledge of the subject, and have advised me to draw up a short and familiar *Introduction*, for the use of such persons. I still cannot help thinking, that, with proper attention, the former work might be sufficient ; but it may be too hard a task for the generality of readers to employ so much attention, as is requisite to connect the distant parts of so large a treatise ; and I would willingly do every thing in my power to facilitate the attainment of this branch of science. I have, therefore,

therefore, attempted a more familiar explication of the fundamental principles of electricity, mixing theory with facts, and illustrating, chiefly, those experiments which are the most entertaining.

IN reality, this treatise has the same object with the former: for we cannot more effectually provide for extending the science, and promoting discoveries in it, than by making what is already discovered easily understood by others; for, hereby, numbers are put in a capacity of carrying the work farther, and are incited and encouraged to attempt it.

I HAVE not directly copied a single sentence from the former treatise,

treatise, except the description of the last mentioned machine, because I imagined it was possible, that, in some cases, a variety in the form of expression only, might assist some persons, who chose to be possessed of them both, to acquire clear ideas of the meaning. For the same reason, I have by no means studied to avoid repetitions, but on the contrary, have, in several cases, contrived to introduce them. For I know by experience, that when we are instructing young persons, or those who are but beginning an acquaintance with any thing, we can hardly use too many words, or vary the form of expression too many ways; too many words being attended with a very trifling inconvenience, in comparison

rison of using too few. In the former case, you may give a little disgust to persons of a quicker apprehension ; but in the latter case, persons of slower apprehensions are necessarily left in ignorance. This extreme, therefore, ought to be avoided with the utmost care.

For this purpose, notwithstanding I have defined all the technical terms in the first part of the treatise, I have given a separate catalogue of them in the fourth with their explanations annexed, and generally in other words, for the reason mentioned above.

BUT I would advise all persons who propose to understand the subject of electricity, though they have no expectation of making discoveries, to provide themselves with

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an electrical machine, or at least desire some of their friends to show them the experiments. Without this, I should despair of making any person whatever a master of the subject. My own ideas were always confused and embarrassed, till I had recourse to this expedient to disentangle them. And I would even venture to say, that the acutest philosopher in the world could not converse about electricity without making many mistakes, and perhaps gross ones, after reading every book he could meet with upon the subject, if he had seen few or no experiments.

N. B. The plates in this treatise are 2, 3, 6, 7 and 8, of the History, and it was not thought necessary to change the numbers of them.

A Familiar

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Familiar Introduction, &c.

PART I.

A Series of Propositions, comprising all the general Properties of ELECTRICITY, illustrated by select Experiments, and especially the more entertaining ones.

SECT. I.

Of the ELECTRIC FLUID.

THE earth, and all the bodies that we are acquainted with, without exception, are supposed to contain a certain quantity of an exceedingly elastic and subtle fluid, which philosophers have agreed to term *electric*. This certain quantity belonging to all bodies, may be called their natural share;

and so long as each body contains neither more nor less than this quantity, it seems to be wholly dormant, and produces no sensible effect: but the moment that the equilibrium is disturbed, and any body becomes possessed of more or less than its natural quantity, very remarkable effects arise from it. The body is said to be *electrified*, and is capable of exhibiting appearances, which are ascribed to the power of electricity.

THIS equilibrium could never be disturbed, or, if it was disturbed, would be immediately restored, and therefore be insensible; but that some bodies do not admit the passage of this electric fluid through their pores, or along their surfaces, though others do. By this means, whenever any body has acquired an additional quantity of electric matter, and is every where surrounded with bodies through which it cannot pass, it must remain overloaded; or, if it have lost part of what naturally belonged to it, it must remain exhausted; because the surrounding

surrounding bodies prevent any of the fluid from going to it, or coming out of it; and the body is then said to be *insulated*. Those bodies, through which the electric fluid can pass, are called *conductors*; and those through which it cannot pass, are called *non-conductors* of electricity; and into these two kinds all bodies whatever are classed by electricians.

THE best conductors of electricity, or those which admit the electric fluid to pass through them with the greatest ease, are metals of all kinds. Water is a pretty good conductor, but animal fluids conduct better than water, and charcoal is a better conductor than either. Other substances, as fresh vegetables, &c. are conductors, chiefly by reason of the moisture they contain; but stones, and earths of various kinds, are conductors in an imperfect degree, independent of moisture.

THE most perfect of the non-conducting class of bodies are *glass, gems, rosin,*

rosin, sealing wax, sulphur, bees wax, baked wood, and dried animal substances, among solids; and *oils and air* among fluids. But all these substances become conductors when they are made very hot. They are also called *electrics*, and the conducting substances are called *non-electrics*.

THE method of disturbing the equilibrium of the electric fluid in bodies, or of making it pass from one to another, is chiefly friction, or a slight rubbing of them one against another. In this case, the electric fluid will, in general, leave that substance which has the rougher surface, and pass upon the other which is smoother; or it will leave that substance which is the less perfect electric, and pass upon the other which is the more perfect electric of the two. Thus, if I take a smooth glass tube, (such as is represented pl. 2. fig. *a*.) and draw it through my hand; the effect of that friction is, that the electric matter leaves my hand, and passes upon
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the glass, where it will remain, as an addition to its natural quantity. For as neither the glass, nor the air which surrounds it, are conductors of electricity, this redundancy of the electric matter cannot possibly get away; but if my finger, a piece of metal, or any conducting substance, be presented to any part of the glass, thus overloaded with the electric fluid, it will pass immediately from that part into them; and if they be presented to every part of the tube successively, the whole of this redundant electricity will be discharged, and every thing will become just as it was before the operation. The glass, in this case, is said to be *excited*; because the friction seems to excite, or call up the electric power, which it had before, but which lay dormant in it.

IN like manner, when the globe is whirled in the electrical machine, the friction of the glass against the rubber (as *f. pl. 7.*) makes the electric fluid, which was in the rubber, pass upon the glass;
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from whence it is conveyed to the prime conductor, (*l*, *k*.) the points of which (*m*) are presented to every part of the globe in succession. And, as the friction is continued, there will, by this means, be a constant supply of the electric matter to the prime conductor, though other bodies be presented to it, and keep discharging it all the while, in visible sparks. The hand, in the former of these cases, and the rubber, in the latter, which had parted with their share of the electric fluid to the glass, against which they were rubbed, receive an immediate supply from the conducting substances in contact with them; and these are, again, supplied by the general mass of the fluid that is lodged in the earth.

ON the contrary, if I draw through my hand a stick of sealing wax, a piece of sulphur, or a tube of rough glass, the effect of the friction is, that a quantity of electric matter naturally belonging to the sulphur, &c. passes from it to my hand; and the sulphur being surrounded by the
air,

SECT. I. TO ELECTRICITY.

air, which is a non-conductor, remains exhausted, and is ready to take sparks of electric fire from any bodies that are presented to it. But it is impossible to distinguish by the eye, which way the electric matter passes, its velocity is so extremely great. The sulphur, in this case, though deprived of its share of electricity, is said to be excited as well as the glass which was overloaded with it; because, though the states they are in be the reverse of one another, the effects produced by them are, in many respects, similar. The appearances which lead us to distinguish them, will be mentioned hereafter.

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S E C T. II.

Of electrical Attraction and Repulsion.

THE great laws of the electric fluid, and those on which all the phenomena of electricity depend, are, that it is, in a much higher degree than air, elastic, and repulsive of itself; that two bodies, having both of them either more or less than their natural share of it, repel one another; but that, if one of them have more, and the other less than its share, they will attract one another.

Thus, if I hang a bundle of hairs or feathers upon the prime conductor, the moment I electrify them, by turning the wheel of the machine, they begin to fly from one another; so that some of them will stand quite erect, in a beautiful manner, and they cannot be made to collapse, and be brought into contact with one another, till I discharge the conductor, by taking a spark from it with a piece of metal, or some other
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conducting substance. A large plummy feather, also, grows beautifully turgid when it is electrified, expanding its fibres in all directions; and they collapse when the electricity is taken off.

IF I hold in my hand a bundle of threads, hairs, or feathers, and present them to the electrified conductor, the electric fluid, with which the conductor is overloaded, repels the electric fluid from those parts of the threads, &c. which are next to it, into the more distant parts of those bodies, or into my hand, and so into the ground; the consequence of which is, that the threads, having less than their natural share, do strongly repel and avoid one another; and, at the same time, are all strongly attracted by the conductor, which is in an opposite state. If the conductor had been deprived of its natural share of electricity, the bodies presented to them would have had more than their natural share; so that, still, the same appearances of mutual repulsion, and of attraction by the conductor, would have taken place: and, universally, all bodies

that are brought within the influence of electrified bodies, whether they are so by having more or less than their natural share of the electric fluid, become possessed of a contrary electricity. For the same reason, excited electrics of every kind attract all light bodies which are brought within the sphere of their influence.

ELECTRICAL attraction and repulsion are exhibited in a very pleasing manner, by means of a glass tube and a feather. When the tube is excited, by being drawn through the hand, or a rubber, the feather, when brought near it, will be attracted, and jump to the tube; then, after taking some time to get fully saturated with electric matter, (because, being a bad conductor, it can receive it but very slowly) it will suddenly jump from it, and fly towards the next conductor, upon which it may discharge the redundant electricity it has acquired. If no other body happen to be in the way, it will tend towards the ground; but if the electrified tube be held
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under it, it will still be repelled, and driven into the middle of the room, where it may be kept suspended, or be driven about in all directions, almost as long as a person pleases, if the air be dry.

OTHER beautiful effects of electrical attraction and repulsion are shewn at the prime conductor belonging to the machine. Suspend a plate of metal (*o. pl. 2.*) from the conductor, (*t*, which is supported by two pillars of baked wood, and must be supposed to be supplied with electricity from the globe) and underneath it, at the distance of about three or four inches, put another plate of the same size (*n*). Upon the lower of these plates lay a feather, or a small slip of light paper; and, as soon as the wheel begins to turn, the feather or the paper, will be attracted, and jump to the upper plate; from whence it will be immediately repelled, and fly to discharge itself upon the lower; after which it will be ready to be attracted and repelled again. Thus will the feather, or paper, fly from
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the one plate to the other alternately, and with inconceivable rapidity, if the electrification be pretty vigorous. When the pieces of paper are cut into the figures of men and women, they exhibit a kind of dance, which is extremely amusing.

THIS experiment will be the more diverting, if it be accompanied with that of the *electrical bells*, (l. pl. 2.) which depends upon the same principle. Two bells hang by a chain, from a brass rod communicating with the prime conductor, and another bell, with a chain fastened to it, reaching to the ground, hangs in silk from the same rod between them; and a small brass ball, suspended by a silken thread, hangs between each two bells. The consequence of this disposition is, that the two outermost bells, which hang from the prime conductor by brass chains, are electrified, and attract the brass balls which hang in silk; and the attraction being vigorous, they are made to strike the bells with some force, and make them ring.

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Being then loaded with electricity, they are immediately repelled from these outermost bells, and fly to unload themselves, by striking upon the middle bell, which hangs in silk; and from which the electric matter passes to the floor, by means of the chain hanging to it. The brass balls, which may now be called clappers to the bells, are then ready to be attracted by the outermost bells, as at first; and thus the ringing may be continued as long as it is agreeable. The amusement will be heightened, if the operator now and then touch the prime conductor with a brass rod, or with his finger: for then the dancing and ringing will cease, and will not be renewed till the finger or rod be removed. If he conceal this application of his finger, or the rod, with a little art, the figures will seem to dance, and the bells to ring, at the word of command.

SECTION III.

S E C T. III.

Of the ELECTRIC SPARK.

WHEN I present a piece of metal, or any other good conducting substance, to the overloaded prime conductor, the electric matter will pass with violence from the one to the other; an electric spark, with the appearance of fire, will be seen darting between them, and a report, which is usually compared to a snapping noise, will be heard. If the piece of metal that is presented to the prime conductor, be insulated, so that it cannot immediately lose what it receives, it will take only part of the charge from the prime conductor, (the whole of the redundant electricity being divided between them, in proportion to their surfaces) and either of them will give a smaller spark to another body that is presented to them.

WHEN any person stands upon the stool, with feet made of glass, or baked wood,

wood, (such as is represented fig. *c.* pl. 2.) and takes in his hand a chain fastened to the prime conductor; being then insulated, he may be considered as part of the prime conductor; and any part of his body will exhibit all the same appearances which the prime conductor itself will do. Thus, if the finger of any person standing upon the floor be presented to him, a spark of fire will seem to issue from him, and both he and the person that receives it will feel a painful sensation, like a pricking; and the same snapping noise above-mentioned will be heard. Every part of his body will then attract light substances; and the bits of feathers, or the human figures above-mentioned, cut in paper, and laid upon a plate, will perform the same dances that were mentioned before, if the palm of his hand be expanded over them. Also, the hairs of his head, or of his wig, if they happen to be loose, will repel one another, and many of them will stand upright, as it is said they will do when a person is greatly frightened. As these electric sparks, which are attended with

a sensation moderately painful, will be excited wherever he is touched, or wherever he touches any other person, this experiment often furnishes very great diversion. Care, however should be taken, that no sparks be drawn from the eyes, or any part that is peculiarly tender; because it may produce an inflammation, which may have bad consequences. If either of the persons concerned in this experiment hold a brass rod in his hand, (such as represented fig. s. pl. 2.) and give or receive the electric sparks upon the knob of it, he will feel very little; while the person to whose naked skin it is presented, will feel as before.

THE electric spark has not only the appearance of fire, but is capable of actually setting fire to various substances, that are easily inflamed: but the inflammation is probably produced by the rapid motion into which the parts of the substances are thrown, by the action of the electric matter upon them. Thus, if spirits of wine, a little warm, be held
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in a spoon, and an electric spark be drawn from the spoon, so as to pass through any part of the spirits, they will catch fire, and burn as if they had been lighted by a candle. The spoon, in which the spirits are contained, may either be connected with the prime conductor, and the spark drawn through them by a person standing on the floor; or the spoon may be held by a person standing on the floor, and the spark be drawn through them by a brass rod, either connected immediately with the prime conductor, or held in the hand of a person standing on the stool, in the manner mentioned above. If a candle be blown out, and an electric spark be immediately drawn through the smoke, it will often be lighted again; but it requires a pretty strong spark, and some degree of dexterity and experience in the operator, to produce this effect with certainty. It will be more amusing, and the effect will be as certain, if the spark be drawn through the spirits by the end of a person's finger, or even by a piece of ice.

Not only are the senses of feeling, seeing, and hearing, affected by electricity, in the manner described above, but it is even sensible to the smell, and the taste. If a pointed brass rod be electrified, either by being fastened to the prime conductor, or held in the hand of a person electrified, and another person, standing upon the floor, present his nostrils within an inch or two of the point, he will feel a strong and disagreeable smell, like that of burning sulphur; and if he receive the electric effluvia issuing from the point, upon his tongue, he will perceive a taste, which is manifestly acid.

SECTION

S E C T. IV.

Of the Influence of Points in Electricity.

THE more acutely pointed any bodies are, the more easily do they take or part with the electric matter. Thus, if a needle, or sharp pointed wire, be fastened to the prime conductor, it will retain but a small degree of electricity, and consequently, will give but a small spark, when the finger, or a piece of metal, is presented to it. Also, if the needle, or sharp pointed wire, be held in the hand of a person standing upon the floor, and presented to the conductor, it will, likewise, be found to retain but a small degree of electricity. In the former of these cases, while the needle was in contact with the prime conductor, the electric matter went off at the point, and was dispersed in the air, or among the conducting particles which are always floating in the common atmosphere. In the latter case, the needle, being presented towards the conductor,

ductor, received the electric matter from it at a considerable distance.

If these experiments be made in the dark, a flame will be seen at the point of the needle or wire; but the appearances of the fire will not be the same in both cases, but considerably different; so that it may always be perceived by the eye, whether, according to the common theory, the point be receiving or giving out the electric matter.

If the sharp pointed wire be giving out the electric matter, the flame will be large; the parts of which it consists will be fewer; and, if the point be not very acute, a kind of snapping noise will be heard as the electric matter is issuing out of it into the air: whereas, if the pointed wire be receiving the electric matter, the flame will be much smaller, and more globular; the parts of which it consists will be more in number, and the noise that is made will be a kind of hissing.

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THESE appearances are distinguished by different names in most foreign languages; and sometimes, in English, the flame issuing from a body, on account of its oblong form, is called a *pencil*; and the latter, because it is more round, and the rays of which it consists project more equally from the center, is called a *star*.

THE reason why pointed bodies transmit the electric fluid with so much ease, has not yet been thoroughly explained, but the effects of it are exceedingly remarkable. The capital use that has been made of this observation, has been, to draw the electric matter from the clouds, and thereby to prove, that lightening and electricity are the same thing. For if a long rod, or pole, with a sharp pointed wire at one end of it, be supported by electric substances, the point, projecting towards the clouds, will draw the electric matter from them, and become sensibly charged with electricity; just as it would have been from being connected with the prime conductor of an electrical machine.

machine. It will attract light bodies, sparks of electric matter may be drawn from it, and it will exhibit every other appearance of common electricity; as, on the other hand, by common electricity, we can produce, in miniature, all the known effects of lightening.

SEVERAL amusing experiments depend on this property of pointed bodies, to transmit the electric fluid. If a plate of tin be cut into the form of a star, and be supported on its center by a wire projecting upwards from the prime conductor; as soon as the wheel of the machine is turned, and this apparatus electrified, a flame will appear at the extremity of every angle of the star, which will be very beautiful; and if the star be made to turn swiftly on its center, an entire circle of fire will be seen in the dark. This experiment will be very surprizing to persons unacquainted with electricity, if the operator, now and then privately touch the prime conductor, which may easily be managed, as it is performed in
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the dark ; for, by this means, he may command the appearing or disappearing of the star, or circle of fire, at pleasure.

If a sharp pointed wire be bent, with the two ends at right angles, in the same plane, but pointing different ways, and be made to turn upon a center ; (see *m*, pl. 2.) the moment it is electrified, a flame will be seen at each point : but what is most surprizing in the experiment, is, that the wire will, at the same time, begin to turn round, in the direction opposite to that to which the points are turned, as if some invifible power acted upon the points and pushed againft them ; and, if the electrification be continued, the motion will prefently become very rapid. If the figures of horfes, cut in paper, be faftened upon thefe wires, and they be fo contrived, that the points fhall be in their tails, the experiment will be very beautiful ; the horfes will feem to purfue one another, though without a poffibility of either of them overtaking the other ; and this is called *the*

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electrical horse-race. It is possible to make several of these wires, each having a considerable number of points bent backwards, with horses, &c. fastened to each of them, and turning one above another; and then, some of them may be contrived to move faster than the others. They may also be made to move different ways.

SECT.

S E C T. V.

Of Positive and Negative Electricity.

THE electric matter, with which the prime conductor is loaded, is not produced by the friction of the globe against the rubber. It is only collected by that operation from the rubber, and all the bodies that are contiguous to it. So that if the rubber be well insulated, by being surrounded on all sides by electric substances, the friction of the globe will produce little or no electricity. For, in that case, the rubber can only part with its own share of electric matter, which is very inconsiderable. In this situation, if a brass rod, or a finger, be presented to the rubber, a spark will be seen to dart from them to the rubber, to supply the place of that electric matter which had passed from it to the globe; and if the prime conductor be insulated as well as the rubber, these sparks will cease, as soon as it is fully loaded; but they will flow very fast, if a chain be hung upon the prime conductor, in order to connect it with the

floor; for, by this means, all the fire which is drawn from the finger, or any other bodies presented to the rubber, and which passes by the way of the globe to the prime conductor, will be conveyed to the ground; so that the rubber will be kept continually exhausted, all the electric matter it receives being immediately conducted from it to the common mass in the earth.

IF, in this case, that is, while the prime conductor is connected with the floor, by a chain hanging from it, another insulated conductor (as *t*, pl. 2.) be connected with the rubber, (which is likewise insulated) it will, like the rubber, of which it may be said to be a part, be deprived of its natural share of electricity by the friction of the globe. It will, therefore, have less than its natural share, and, consequently, be ready to take electricity from any bodies that are presented to it. Now, because, in this case, it seems to act like the former prime conductor, when it was electrified, this is said to be electrified too; but,

but, to distinguish them from one another, the former is said to be electrified *positively*, having more than its natural share of the electric fluid; whereas the latter is said to be electrified *negatively*, having less than its natural share.

THESE two electricities, though they are the reverse of one another, are, in many respects, similar, and produce the same sensible effects. All the difference that is visible between them, is in the appearance of the electric fire at the points of bodies electrified positively and negatively, which was mentioned above. If the wire be electrified positively, that is, if it be connected with the positive conductor, or presented to the negative conductor, what was called the *pencil* of electric light, appears; but if the wire be electrified negatively, that is, if it be connected with the negative conductor, or presented to the positive conductor, the *star* will be seen.

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IF a globe of sulphur, sealing wax, or baked wood, be used, and the rubber be the human hand, or a piece of leather, the effects, in all the cases mentioned above, will be the very reverse of those produced by a globe of glass; for the friction of the sulphur and this rubber will make the electric matter pass from the sulphur to the rubber; the consequence of which will be, that the insulated prime conductor will give all the electric matter it is possessed of to the globe, and remain exhausted, or negatively electrified; whereas the rubber, and the conductor connected with it, will, for the same reason, be overloaded, or electrified positively.

IF any body have received a spark of one of these electricities, a spark of the other kind will unelectrify it. Thus if two persons be insulated, standing upon stools with feet of glass, or baked wood, and one of them, be electrified positively, and the other negatively; either of them, being touched by a person standing on the
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the floor, will give a moderate spark; but if they touch one another, the spark will be much stronger, and they will both be unelectrified, as effectually, as if they had been touched by a person standing on the floor. In this case, one of these persons having more, and the other less than his natural share of electricity, the effect of their communication will be, that the redundancy of the one will just supply the defect of the other; so that, after contact, they will both remain in their natural state, and will give no spark at all upon being touched by a person standing on the floor. But if both these persons had been electrified positively, or both negatively, there would have been no spark upon their touching one another for both being overloaded, or both being equally exhausted, the electric matter could no more pass from the one to the other, than it could from one part of the same body to another part of it. These persons, therefore, touching one another, would be the same thing, as either of the persons,

sons making one of his hands touch the other; and, after contact, they would, either of them, give or take a spark, upon being touched by persons standing on the floor, just as they would have done, if they had never touched one another at all.

THE difference between positive and negative electricity will be farther illustrated, when I treat of the charging of electric substances, in the next section. I would observe, that it is not very easy to insulate a rubber so perfectly, as that there shall be no constant supply of electric matter to the globe, and the prime conductor through it. To succeed the best, the globe should be very large, and the rubber very small and round; for if there be any sharp point or edge about it, it will be impossible to prevent its receiving a supply of electricity from the atmosphere; and if the globe were made so very large, and the rubber so very small, as would be necessary for the compleat demonstration of these facts, the

the friction would not produce a quantity of electricity for other experiments. But it is very easy to insulate the rubber so much, that the supply it receives from the atmosphere shall not be very considerable; so that the sparks which are given to it, or to a conductor connected with it, shall, to all appearance, be as large and strong, as those drawn from the prime conductor supplied by the globe itself; that is, the negative electricity, produced in this manner, shall be as powerful as the positive.

S E C T. VI.

Of charging electric Substances.

IT was observed before, that the electric matter in one body repels the electric matter in another, when it is brought within the sphere of its influence, and makes it retire into the more remote parts of the same body, or into other bodies that are contiguous to it. This will explain the nature of what is called the *charging* of glass, and other electric substances. If a plate of glass, (which is impermeable to the electric fluid) have a plate of metal in contact with each side of it, not coming nearer than an inch or two of the edge; (see *b*, pl. 2.) and one of these plates of metal (which, in this situation, are called the *coating* of the glass) be made to receive a spark of electric matter from the prime conductor, while the plate on the other side of the glass has a free communication with the earth; the redundancy of
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the electric matter now thrown on one of these plates, and one side of the glass, will extend its influence to the other plate, and the other side of the glass; and repelling the electric matter which was natural to them, will make it retire into the next conductors. If the former side be made to receive a greater quantity or charge of the electric fluid, the other side will, for the same reason, continue to be more and more exhausted, till at length one of the sides will have received as great an additional quantity of electric matter as it can receive, and the other will be exhausted as far as possible.

IN this state, the plate of glass is said to be *charged*; the meaning of which is, that one of the sides has gained an additional quantity of the electric matter, and the other has lost as much as was equal to it. In other words, one of the sides is electrified positively, and the other negatively, and both in the same degree. Or, again, as it is sometimes expressed, the equilibrium of the fluid, naturally

belonging to the glass, is destroyed, part of it being removed from one side, and transferred to the other.

THE discharge of this plate of glass is made, by restoring the equilibrium, which was destroyed by the charging; and it is effected by forming a communication between the overloaded and the exhausted side; and if the communication be made by metal, or other very good conductors, the equilibrium will be restored with violence; the redundant electricity on one side will rush, with great rapidity, through the metallic communication to the exhausted side, and a large explosion will be made; that is, the flash of electric light will be very visible, and the report will be very loud.

THE reason why the equilibrium cannot be restored, without forming an external communication betwixt the positive and negative side of the glass, is, that the electric matter cannot pass through the substance of the glass, on account

account of its being a non-conductor; and therefore, though the distance between the positive and negative side be so very small, and the attraction between them, as was explained above, so very great, the plate would always remain charged, if the moisture in the air, or some other conducting substances, did not serve to convey the electric matter from one side to the other.

THE possibility of charging a plate of glass to so great a degree, as we see it is, in fact, capable of bearing, seems to argue, that the substance of glass naturally contains a very great quantity of electric matter; because no addition of electricity can be thrown upon one side of the plate, but an equal quantity must leave the other; which, therefore, must have existed in its pores, or have lodged on its surface before. That it is not contained in the metal, which forms the coating, is evident, because the plate of glass is capable of being charged without the coating, as will be explained hereafter.

THE

THE thinner the glass is, the stronger is the charge which it is capable of bearing; because the electric matter, which is added to one side, is nearer to the electric matter which belongs to the other side of the glass, and therefore can act upon it with more force, and, consequently, expel a greater quantity of it.

SOMETIMES, when a plate of glass is charged very high, and especially, if it be very thin, it will explode of itself, and a hole will be made through the glass. In this case, a white spot is made in the glass, a part of it being absolutely pulverized; and very often cracks extend, in all directions, from every side of the hole.

OTHER electric substances may be made to receive a charge of electricity. Even *air* may be used for this purpose; for plates of metal hanging parallel to one another, and, consequently, having a plate of air, as it may be called, between them, exactly resemble the coatings of a plate of glass, with the substance of the glass between them.

THE

THE shape of the glass is of no consequence, with respect to its power of receiving a charge; and, in general, the most commodious form is that of a phial or jar. Jars are more easily removed from place to place, and may be handled and managed more easily than flat plates of glass. Besides, less of the glass is lost in this form than the other; for, in order to prevent the plate or the jar from discharging itself, by the electric matter jumping from one of the coatings to the other, it is necessary that they be kept at a considerable distance from one another: and two or three inches on every side of a flat plate of glass, which must be left uncoated, is much more than two or three inches of the neck of a jar; particularly, if it be made very narrow. Also, the uncoated part, being small, may be more easily wiped, and kept clean and dry, in a jar, than in a plate. The forms of several coated jars, &c. as fit for different purposes, may be seen in plate 2, fig. *c, d, e, f, g, h, i, j, k.*

As

As it is indifferent which side of a plate of glass be charged with electric matter, and which side be exhausted, so it is equally easy to charge either the inside or the outside of a glass jar. If the inside be charged, the outside will be exhausted; and if the outside be charged, the inside will be exhausted; to charge the inside of a jar, the brass rod, which touches the inside coating, must be presented to the prime conductor, and the outside held in the hand, or touch some conducting substance communicating with the earth. To charge the outside, the rod must be held in the hand, and the outside coating be presented to the prime conductor. If, after this, a person should chuse to quit his hold of the brass rod, and take the jar by the outside, he must first set it down upon an electrical stool or stand, and then he may lay hold of it wherever he pleases, without giving himself a shock.

If the prime conductor be electrified negatively, presenting to it the wire, which communicates with the inside of
the

the jar, will exhaust the inside, and, consequently, charge the outside; and if the outside be presented, that will be exhausted, and the inside charged.

If a cork be put in a jar, or a phial, and the wire be made, with a hook, to hang upon the prime conductor, (as *k*, pl. 2.) it may easily be proved, that no electric matter can enter the inside, except an equal quantity can pass from the outside; for while it hangs from the prime conductor, it is incapable of being charged, unless the outside be touched by the hand, or some other conducting substance, which may give the electric matter, that is lodged on the outside of the glass, an opportunity of making its escape, as fast as any additional quantity is thrown into the inside.

If two jars be charged alike, either both the insides positively, and, consequently, both the outsides negatively, or the reverse; and if their outsides be connected by a chain, and their wires be

G

brought

brought together, there will be no explosion; for both of them being in the same circumstances, either loaded or empty, neither of them has any thing to impart which the other wants. But when one of them is charged positively, and the other negatively, and a chain connects their outsides; then, if their wires be presented to each other, there will be a great explosion, and both will be discharged: for the one being loaded, and the other exhausted, the electric matter will rush from the one to the other; and this will be done with ease, as, the outsides being in contact likewise, a like passage of the electric matter will, at the same time, be made through the chain, whereby the charge which lay on the outside of the one of them, will pass into the outside of the other, which was exhausted.

It may also be known, by a very pretty experiment, whether two jars be charged alike, or differently. Let them stand near together, and especially upon a plate
of

of metal. In this situation, if a cork ball, or a feather, be hung in a silken string, and brought to one of the wires, it will catch some of the electricity, of whatever kind it was, and will be immediately repelled; and it will also be repelled from the other wire, if that jar had been charged in the same manner; and so long as any electricity remains in the ball or feather, it cannot be made to touch either of them: but if the other jar be charged differently, the cork ball or feather will fly betwixt them with great rapidity, taking from the one and giving to the other, till both be discharged.

WHEN a jar is charged either positively or negatively, before it can be charged the contrary way, the former operation must be reversed; and, as it cannot be perceived by the eye, which way an electric spark goes, whether into the jar, or out of it, it is amusing to see a jar, already charged, seem to be receiving a greater charge, and yet, after some time, be found to have no charge at all. This will be the case, if, when it has been

charged at a positive conductor, it be afterwards taken to a negative one, and be held to each about the same number of turns of the wheel. It is difficult, however, to hit the exact time when the first charge shall be taken out, and no opposite charge be thrown into it.

To make the nature of charging and discharging a jar the easier to young electricians, *k. pl. 2.* represents a jar hanging by its wire from the prime conductor, while a chain connects the outside with the table. In this situation, if the wheel of the machine be turned, it will receive a charge, and may then be removed from the prime conductor. To discharge it, the brass rod, *s*, being held in contact with the chain, which touches the outside of the jar, must be brought to the brass knob at the end of the wire; or it may be brought to any part of the prime conductor, if the wire remain in contact with it, as it was while it was charged, and have not been removed from it. In either of these cases, a flash of fire will be seen at the
brass

brass knob, or at the prime conductor, and a report will be heard ; but the person who makes the discharge will feel nothing of it, though he holds the chain and rod in his hand, the fire passing directly through them without entering any part of his hand, in order to go the nearest way, and through the best conductors, to come to the other side of the jar. For when a jar is charged, the discharge is always made the nearest way, through the best conductors. But the electric matter will go a great way through a better conductor, as through metals, rather than a very short way, through a worse conductor, as moist wood or water. And it has not been found, that it takes the least sensible space of time in passing through the greatest distances.

WHEN a phial, or plate of glass, is charged without any coating, that part only receives the charge which is in the neighbourhood of the wire, or other conducting substances that touch it ; but if the wire from the prime conductor be made to touch all the parts of it in succession,

cession, while the other side is touched by the hand, or any conducting substance communicating with the earth, the naked glass will be charged as high as the coated. But then, for the same reason, it can only be discharged partially, those parts only being discharged which are in contact with the extremities of the electric circuit, and the parts in the neighbourhood of them. However, in general, a glass jar, of no great dimensions, may be more than half charged, or discharged, by bringing the conductor in contact with only one part of it.

If a bottle, with water in it, be used, without any coating on the outside, it will be charged very well, provided it be held in a person's hand while the wire receives sparks from the prime conductor; or, if the outside be touched by another wire, which is now and then removed from one part of it to another. And, if one end of the discharging rod touch the outside of a bottle charged in this manner, and touch the wire communicating with the inside, with the other end, the jar will be more than half dis-

discharged. In this case, the phial makes a fine appearance; for, from the place where the discharging rod touches the outside of the phial, the fire will seem to branch out, and make the most beautiful ramifications all over the phial, and, in the dark, will give an intense light.

If any part of the human body be made a part of the electric circuit, or be so placed, that the fire of the jar must pass through it, in its way from one side to the other, a violent shock is given, which affects the nerves and muscles like a convulsion. Thus, if a person touch the outside of a charged jar with one hand, and bring the other hand to the wire communicating with the inside, the fire will rush from the inside of the jar, (if it was charged positively) and pass through his arms and breast, as its nearest way to the outside. If a number of persons join their hands, and a person, at one extremity of the circuit, touch the outside of the jar, while another person, at the other extremity, touches the wire, the fire must, for the same reason,
pass

pass through all their arms and breasts, and they will all feel the shock alike. When many persons thus join their hands, and take a shock together, the experiment is very entertaining. It is particularly amusing to the operator, to observe how a number of persons, who never felt a shock before, are affected by it, and to hear them describe their several feelings.

ELECTRIC shocks may also be given to any particular part of the body, without affecting the rest, by bringing that part only into the electric circuit. Thus, if I would give a shock to my arm only, I make the brass chain, which communicates with the outside of the jar, touch my shoulder, while a discharging rod is held in my hand: and, in this manner, the fire may be made to come in and go out at whatever place a person pleases. But if the charge be strong, the parts in the neighbourhood will be affected, as well as those which lie directly in the path of the fire.

To

To make this operation the easier, Mr. Lane has contrived an instrument, *r*, pl. 2. and *c*, fig. 2. pl. 6. It consists of a brass rod, put through a brass ball, supported by a pedestal of baked wood. By means of an index annexed to it, the knob of this rod may be placed at any given distance from the wire of a jar, or the prime conductor with which it communicates. In this situation, if one end of a wire, twisted about this brass rod, touch one part of the body, while another wire, from the outside of the jar, touch any other part; as soon as the jar is charged so high, that the explosion can pass the interval between the rod and the wire, there will be a discharge, and the part of the body between the two wires above-mentioned will be shocked. If things remain in this situation, the operator need only to keep turning the wheel of the machine, and the patient will receive as many shocks, of precisely the same strength, as he pleases.

IF a few leaves of a quire of paper, or the cover of a book, be intercepted in the circuit of an electrical explosion, they will be perforated by the discharge, and the hole will give a strong smell of sulphur.

A NUMBER of jars combined make what is called an *electrical battery*, such as is represented pl. 3. where all the jars stand in a box, the bottom of which is covered with tin. The wires belonging to one of the jars are all made to connect with one rod, which has a brass knob at each end; and all the rods, or any number of them, may be connected by a brass chain laid over them.

THE effect of a considerable force of electricity, thus accumulated, is much greater than could well be imagined from what can be done by a single jar. If a small wire be made a part of a circuit, it will be made red hot, be melted, and even calcined, vitrified, or totally dispersed. If gunpowder be placed in contact with

this small wire, it will take fire upon the explosion; as also, if it be made up into a cartridge, and two wires (part of the circuit) be placed at the distance of about a quarter of an inch from one another, in the inside of it.

WHEN the surface of water, the leaves of vegetables, the flesh of animals, and some other conducting substances, of a middle class, are made part of the circuit, and the distance is not very great, the electric fire, instead of passing through these substances, will often pass visibly over the surface, giving a prodigiously intense light, and making a report far exceeding that which is made when the explosion is received between two pieces of metal. If the fire of the charge enter the water, &c. instead of passing over the surface, the sound of the report is very dull, and the colour of the spark is red, which is universally the case when the electric circuit consists of bad conductors.

S E C T. VII.

Of the Electric Light in Vacuo.

SOME of the finest appearances of electric light are exhibited in *vacuo*. For, in passing through the air, which is a non-conductor, it is confined, as it were, to a narrow path, and a short distance; whereas it diffuses and spreads itself to a greater distance in *vacuo*; and the medium making no resistance, the electric spark may be made of any length whatever. If a tall receiver, with a wire inserted into the top of it, be exhausted, the electric spark, taken at the knob of the wire, will dart through the whole length of the vacuum, to the plate on which the receiver stands, and in its passage, will spread itself, and divide in a most beautiful manner.

IN *vacuo*, the difference between positive and negative electricity is very remarkable. It is only the pointed wire electrified positively, that will throw out the beautiful streams of electric light mentioned

mentioned above, which extends itself from one end of a tall receiver to the other. If the point be electrified negatively, there will be at the end of it a kind of a ball of fire, consisting of rays so small, as to be hardly distinguishable separately, and which will not form themselves into large and dense streams. However, the appearance is very pleasing. If the vacuum be made a part of the electric circuit, the fire of an explosion will dart through the very center of it, in the form of a compact ball of fire, be the distance ever so great. Whereas, when single sparks are taken, the electric matter, not rushing with so much impetuosity, is generally attracted to the sides of the glass, along which it runs, in a variety of currents, which frequently change their course.

S E C T. VIII.

Of the Methods of ascertaining the Kind and Degree of Electricity.

IN many electrical experiments, it is very convenient to have a method of determining, whether a small degree of electricity be positive or negative; and, in using large batteries, it is a matter of consequence to know how the charge advances, and of what strength it is. Mr. Canton's balls are extremely useful for both these purposes. They are made of the pith of elder turned perfectly globular, and suspended by fine threads, in a small box, as represented upon the glass standing on the stool *c*, pl. 2.

To understand the use of them, suppose a jar or battery stand upon the table, and I want to know whether the inside be charged positively or negatively. In order to this, I present the balls, and they are immediately attracted by the wire, and diverge from one another.

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This is common to both electricities, and the greater the distance to which the balls separate, and the farther they repel one another the higher is the charge. To determine of what kind it is, I rub a small piece of glass (which I carry about with me for the purpose) against my hand, or coat, which I know will excite it positively, and then present it to the balls in their diverging state. If it make the balls converge and consequently avoid the glass, it shows that they are electrified positively, as well as the glass. On the contrary, if it increase their divergency, and attract them, it shows their electricity to be of a kind opposite to that of the glass, that is, negative. And it must be remembered, that the electricity of the balls (which do not touch, or receive any electricity from the wires of the jar or battery) is always contrary to that with which they are charged; for, as was explained above, all bodies placed within the influence of electrified bodies, are affected with the contrary electricity.

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IN order to ascertain the kind of an exceeding small degree of electricity, it will be convenient to have a very light body, as a piece of a downy feather hanging by a filken thread. This light body, when it is once electrified, either positively or negatively, will retain its virtue a long time, with very little loss. If then any body, the electricity of which is unknown, be brought to it, the feather will be repelled by it, if it be of the same kind with its own, and attracted, if it be contrary to it. The silk, by which it is suspended, should be a single thread, as it comes from the worm, or, at least, a very few of those threads, and the whole should be as light as possible.

THE force of a shock, after the explosion, may be measured by Mr. Lane's electrometer, mentioned above; and by Mr. Kinnerley's, which is represented *q*, pl 2. as fastened to the same pedestal which supports Mr. Lane's. It consists of a cylinder of glass, through the caps of which are inserted brass rods with knobs, which

which may be placed at any distance from one another. These are made part of the electric circuit, and the fire of the discharge darts from the one to the other. The force of the charge is measured by the quantity of air displaced by the passage of the electric matter; and this is shewn by a small glass tube, inserted with cement through the upper cap, and let into a small quantity of water at the bottom of the cylinder, which will rise in the tube, in proportion to the force exerted upon it by the displacing of the air.

P A R T II.

Practical Directions for using Electrical Machines, and for conducting Electrical Experiments.

WHEN the air is dry, and particularly when the wind is north, or east, electrical machines will always act to the best advantage. If the air be moist, the globe should be made very clean and dry, before it be used; and then, if there be a fire in the room, and especially if the rooms adjoining to it have fires in them likewise, the state of the air will be no impediment to excitation.

To increase the quantity of electric matter, in order to a vigorous electrification, the rubber should not be kept quite dry; for a slight degree of moisture is a great

great advantage to it, though too much will entirely prevent the excitation. But nothing has yet been found of so much use, as putting a little amalgam upon the rubber. An electrician will seldom be without tinfoil, for the purpose of coating jars; and the amalgam is readily made, by working the waste pieces of it with a little quicksilver in the palm of the hand, till it be of the consistence of paste. A very little of this will serve a considerable time; for, by frequent use of the amalgam, an incrustation will be formed upon the rubber, which is a much better covering to it than the surface of the leather itself. After this, a little moisture, but more especially a little tallow, will generally do as well as fresh amalgam; or scraping it a little now and then, so as to take away the inequalities which will be formed upon its surface, will answer the same purpose.

As all the electricity with which the prime conductor is supplied, is collected from the neighbouring bodies, and passes

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through

through the rubber; it is necessary that the rubber have a free communication with the earth, by means of good conducting substances. If the wood of the machine, or of the table, therefore, be very dry, a chain, or a piece of wire, should hang from the rubber to the floor.

If a smooth glass tube be used, the best rubber for it is a piece of oiled silk, with a little of the same amalgam put upon it. I have seen a little bees-wax drawn over the tube, before the friction, have a very great effect. When the smooth tube is in very good order, pencils of electric matter will dart into the air from several places of it spontaneously, and make a very beautiful appearance.

If a rough tube be used, in order to electrify negatively, the best rubber will be a piece of new soft flannel, or the skin of a hare or a cat. The manner in which the electric matter spreads upon the surface of a rough glass tube, when a person's knuckle, or any other conducting

ing substance, is presented to it, immediately after the friction, is very pleasing.

The larger is the prime conductor, or rather, the greater surface it has the greater quantity of electric matter it will retain, and the stronger sparks it will give. The prime conductor may be made so large, that single sparks taken from it shall be equal to a shock from a charged phial. But the less the prime conductor is, the less loss there is of the electric matter by dissipation into the atmosphere, and therefore the more convenient it is for charging jars and batteries. The longest sparks may be drawn from the prime conductor at those parts of it which are the most remote from the globe.

THE uncoated part of glass jars should be kept clean and dry, in order to contain as great a charge as possible. It is also very useful to warm them a little before they are used. This will often render the wiping of them unnecessary, and is more especially advisable in large batteries, as it would require a considerable

ble time to wipe every single jar. This, however, should be done when they are very dusty, though dust alone, if it be quite dry, occasions little or no obstruction to the charging; whereas the slightest degree of moisture, connecting the inside and the outside coating, will effectually prevent the charge. In order to charge jars and batteries with the most ease, it is advisable to connect their outsides by a wire or chain to the rubber. By this means, the very same electric matter which was dislodged from the outside, is transferred to the inside; and in this case also, the dryness of the table, or of the wood of the machine, is no hindrance to the charge being carried as high as possible.

A MEDIUM should be observed in coating jars, in order to make them hold the greatest charge. If they be coated very high, so that the two coatings be near together, the charge can be but very moderate; since, before it can be carried to any considerable height, a spontaneous discharge will be made, by the fire jumping

ing from one coating to the other, without the help of any circuit of conducting substances. But, on the other hand, if the two coatings be very far asunder, there will be left only a small part of the surface of the glass on which the charge can lodge, and therefore it must be proportionably small. Besides, in this case, the danger of the bursting of a jar by a spontaneous discharge is the greater, the distance of the coatings admitting it to be charged to a very great height. These spontaneous discharges by bursting the glass are a great inconvenience in large batteries, and therefore the jars which compose them should be coated higher than jars which are used singly.

I SHALL conclude this chapter of precepts, with advising all young electricians to be exceeding cautious in using large batteries, and to be sure that they are perfectly masters of a small force, before they meddle with a greater. So great a force of electricity as may be accumulated in batteries, is not to be trifled with; since the consequences, if not fatal, may
be

be great and lasting. A large shock taken through the arms and breast, which an operator is most in danger of receiving, might possibly injure the lungs, or some other vital part; and if the shock were taken through the head, which may very easily happen, when a person is stooping over it, in order to adjust the apparatus belonging to an experiment, it might affect his intellects in such a manner, as that they should never be what they were before.

P A R T III.*A Description of the more convenient Forms of Electrical Machines.*

THE principal part of every electrical machine is, generally, a globe or cylinder of glass; and the use of the machine is to give it a convenient friction, and to provide a prime conductor, to collect and retain the electric matter excited by it.

THE most elegant of the portable machines that I have seen, is that of which a representation is given pl. 6. fig. 1. *b* represents the globe, which turns upon a vertical axis *c*, by means of a handle *d*, and the wheel-work *i* contained in the box *a*; *e* is the rubber, which may be made to press harder, by means of the screw *f*; and *g* is the prime conductor, suspended on filken strings in the frame *h*.

K

Fig.

Fig. 2. of the same plate, represents a machine, which is also fastened to a table, and is peculiarly useful in medical electricity: *d* represents the cylinder turning on a vertical axis, which goes through the center of it, and is supported by the bow *e*. Motion is given to this cylinder by means of a pully *f*, and the wheel *g*. The prime conductor *a* is a tin tube, furnished with points, and firmly fixed to the wire of a coated jar *b*. When the wheel is turned, this jar is charged; and the machine annexed to it is that which was mentioned before, as being useful to ascertain the force of a shock. When common electrification is wanted, this coated jar is taken away, and an uncoated jar, of the same size, which effectually insulates the conductor, put in its place.

PLATE 7. represents a machine, which I think is peculiarly adapted to philosophical purposes: *a a* represent two parallel boards firmly joined at the ends, from which arise two pillars, one of them, *b*, fixed, and the other movable in a groove cut in the upper board. This frame

frame is screwed to a table. The globe has only one neck, and is turned on an horizontal axis *d*, (supported by a brass arm *c*) by a pulley, and a wheel, which is fixed in a frame of its own, *e*, and which is also screwed to the table. The rubber is separated from the spring *b*, which supports it, by a piece of baked wood, *g*, which effectually insulates it. The spring may be moved in any direction, by means of the groove, and the screw underneath it. The small screw *i*, makes it press more or less at pleasure; and the chain *n*, connects the rubber and the floor, when positive electricity is wanted. The prime conductor *k*, is a piece of hollow copper, in the shape of a pear, supported by a pillar of baked wood, and pierced with holes, for the insertion of brass rods, to convey the electricity wherever it may be wanted. It is supplied with electric matter by means of an arched wire *l*; and the small pointed wires, or needles, *m*, which play lightly upon the globe.

A GLOBE of any size may be used in this machine, as the fixed pillar is pierc-

ed with a variety of holes, by means of which the axis, and all the apparatus belonging to it, may be placed higher or lower at pleasure. Also globes, or cylinders with two necks, and an axis going through them, may be whirled in it, by means of the moveable pillar, which is perforated in the same manner as the fixed one. The chief convenience of this machine, besides the easy insulation of the rubber, and its receiving a globe, or glass vessel of any form or size, is, that the frame, the wheel, the globe, the rubber, and the prime conductor, (which is perfectly steady) admit of every variety of position to one another.

THE machine represented in Pl. viii, is constructed on the same general principles with the last. It is inferior to it in one respect, that it admits only of globes or cylinders with one neck, but these are far preferable to any other; and it is much more commodious for use, as it doth not require any strong table like the other. It consists of a pillar of mahogany *a* stand-
ing

ing upright on three feet. This pillar divides in two places, to receive a wheel *b* in the lower part of it, and in the upper part a pulley *c*, which is turned by a leather strap *d*, tightened by means of a small buckle. In the center of the pulley is a strong iron spindle, turning in two firm brass sockets, fastened to each side of the pillar. In one of these sockets the extremity of the spindle turns upon a center, by means of a piece of iron *e* screwed into it, while the other is held tight by a brass clasp, which may be made to hold it closer, or more loosely, at pleasure, by means of a screw *f*. The iron spindle is made hollow in the form of parallelopiped, in order to receive a piece of brass or iron, in which the brass cap that holds the globe *g* terminates. These are exactly fitted by one another, and by this means any globe may be taken out, and another put into the machine with very little trouble, if these parts be always made to the same pattern,

THE RUBBER *h* is separated from the spring *i* by a plate of glass *j*, which effectually

effectually insulates it; but the chain k connects them together when positive electricity is wanted, as in the usual method of electrifying. The spring may be made to press more or less, by means of a screw l ; and it may be raised higher or lower, to suit globes of different sizes, by means of a contrivance which is not represented in the plate.

THE PRIME CONDUCTOR m, n, o , is the same as in Pl. vii. From the same board which supports it arises another pillar, at the top of which is Mr. Lane's electrometer; the knob of which p may be placed as near to the knob opposite to it on the prime conductor q as is desired by means of the graduated part r . But the whole of this may be taken away when it is not wanted.

WHEN negative electricity is desired, the chain k must be removed from the rubber, and hung upon the prime conductor, so as to connect it with the table; and a short brass rod, with a knob at the end of it, must be screwed into a small socket,

socket, which will be found in the rubber above the plate of glass. This brass rod will then serve for a negative prime conductor; for, in this situation, when the wheel of the machine is turned, this rod being insulated (together with the rubber, through which all the electric fire passes to the globe) will receive sparks from whatever is presented to it, and therefore electrify negatively.

As it requires some dexterity and experience to turn the machine, standing on three feet only, without shaking it; small plates of brass, upon which the edges of heavy weights, made of lead or iron, may be placed, are fastened to two of them; but a large board may be firmly screwed under all the feet, or various other methods may be used, whereby the pillar, which supports the machine, may stand as firm as a person chuses.

P A R T IV.

*An Alphabetical Catalogue of the
Technical Terms used by Writers
on the Subject of Electricity.*

BATTERY, *electrical*, a number of jars combined together, so that they may all be charged and discharged at the same time. The form of one is exhibited pl. 3.

Charging, throwing an additional quantity of electric matter upon one side of a plate of glass, or a jar, while the other side is exhausted in the same proportion. All other electric substances are capable of being charged as well as glass.

Circuit, electric, those conducting substances which are made use of to form a communication between the two coatings of a charged jar or battery, &c. and
through

through which the electric matter must pass, when the equilibrium between the two sides is restored by the discharge.

Coatings, plates of metal, or other conducting substances, laid upon plates of glass, or other electrics, whereby the additional quantity of electric matter, called *the charge*, may be the more easily and uniformly conveyed to them, or discharged from them.

Conductor, prime, a piece of metal furnished with points, to receive the electric matter from the globe, after it has been excited by friction. It must always be insulated, or cut off from a communication with the earth by means of electric substances, such as *glass, baked wood, &c.* Whenever *the conductor* is mentioned, the prime conductor must always be understood.

Conductors, or conducting substances; those bodies through which the electric matter may be transmitted. They are also called non-electrics, because no elec-

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tric

tric powers can be excited in them by friction.

Discharging, restoring the equilibrium of the electric fluid, after it has been disturbed by charging. It is effected by forming a communication between the overloaded and the exhausted side of a glass jar, battery, &c. by means of conducting substances, through which the overplus or charge may pass from the one to the other. When the discharge is considerable, it is often called an *explosion*.

Discharging rod, a brass rod, with a knob at each end, (see s, pl. 2.) very convenient either for taking sparks from the prime conductor, or for discharging jars or batteries. It is sometimes bent into a semicircular form, in order to bring one of the knobs to the outside, and the other to the wire, communicating with the inside of a charged jar, in order to discharge it, by receiving the explosion on its knob.

Electric matter, that subtle fluid which is supposed to be the cause of all those
appear-

appearances which are termed electric. It is sometimes called *electric fire*, and sometimes *ether*.

Electrics, those bodies in which electric powers of attraction, repulsion, &c. may be excited by friction. They are also called *non-conductors*, because the electric matter cannot pass through them.

Electrometers, instruments to measure the degree of electrification; (that is, the quantity of electric matter thrown upon any body) or the force of an electrical explosion.

Excitation, the act of exciting or calling forth electric powers from electric substances, by means of friction, and other methods.

Insulating, placing bodies where they are not in contact with any conducting substance; as by suspending them in the air by silken strings, putting them on glass stands, &c. so that the electricity they may be charged with cannot be conveyed to the earth.

Negative electricity, a less quantity of the electric matter than is natural to any body.

Pencil, the appearance of electric light issuing from the point of a body electrified positively.

Positive electricity, a quantity of electric matter thrown upon any body, above its natural share,

Rubber or cushion, a piece of leather, or any other substance, against which the glass globe, or other electric body whirled in the machine, is rubbed, in order to excite them.

Shock, electric, the convulsion given to the animal muscles by the passage of the electric matter through them, especially in the discharge of a jar or battery.

Star, the appearance of electric light from the point of a body electrified negatively.

Wire

Wire of a phial, a jar, or battery, the wire or metal rod which goes into the inside of a phial, and which touches the inside coating. This wire is therefore often put for the inside coating.

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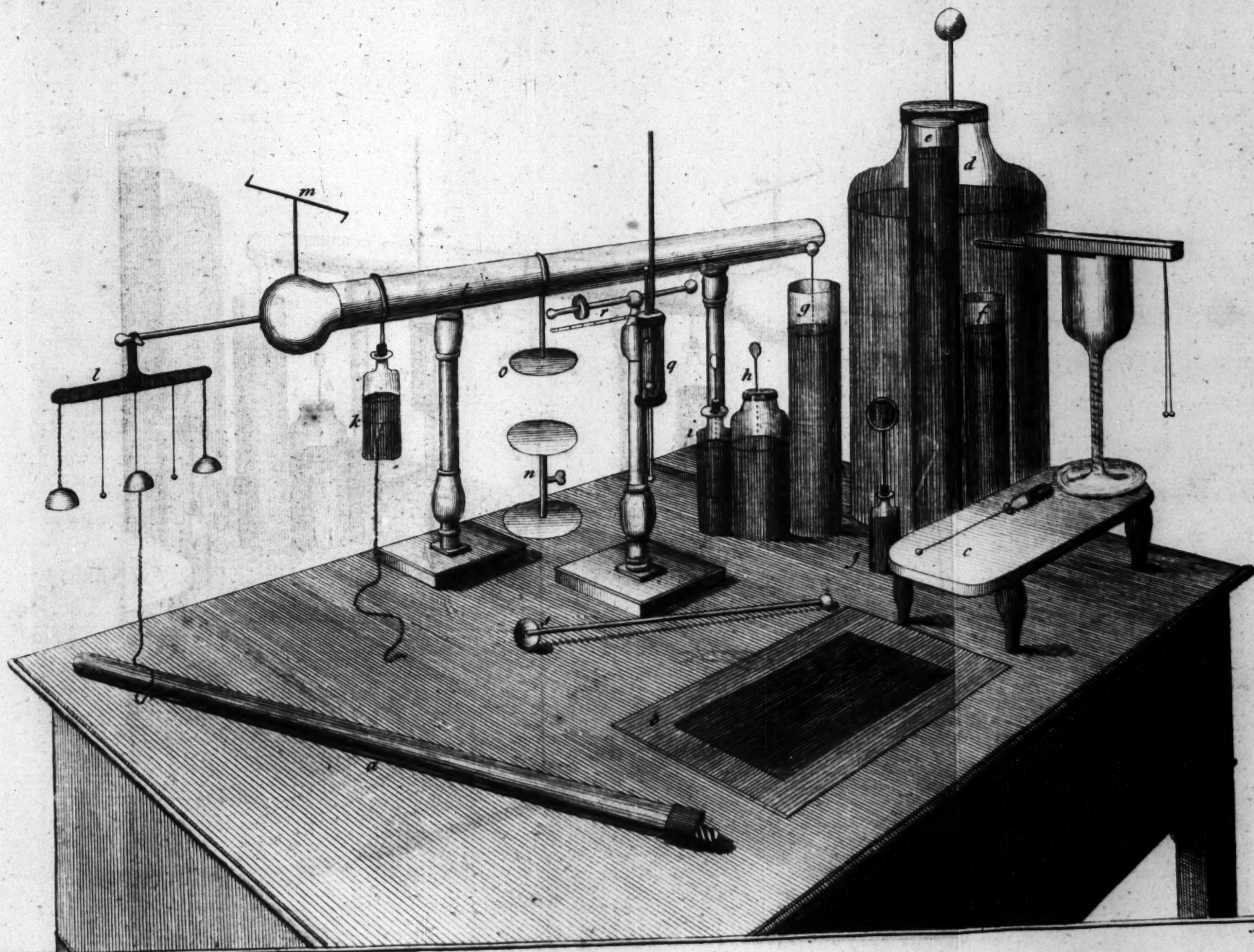
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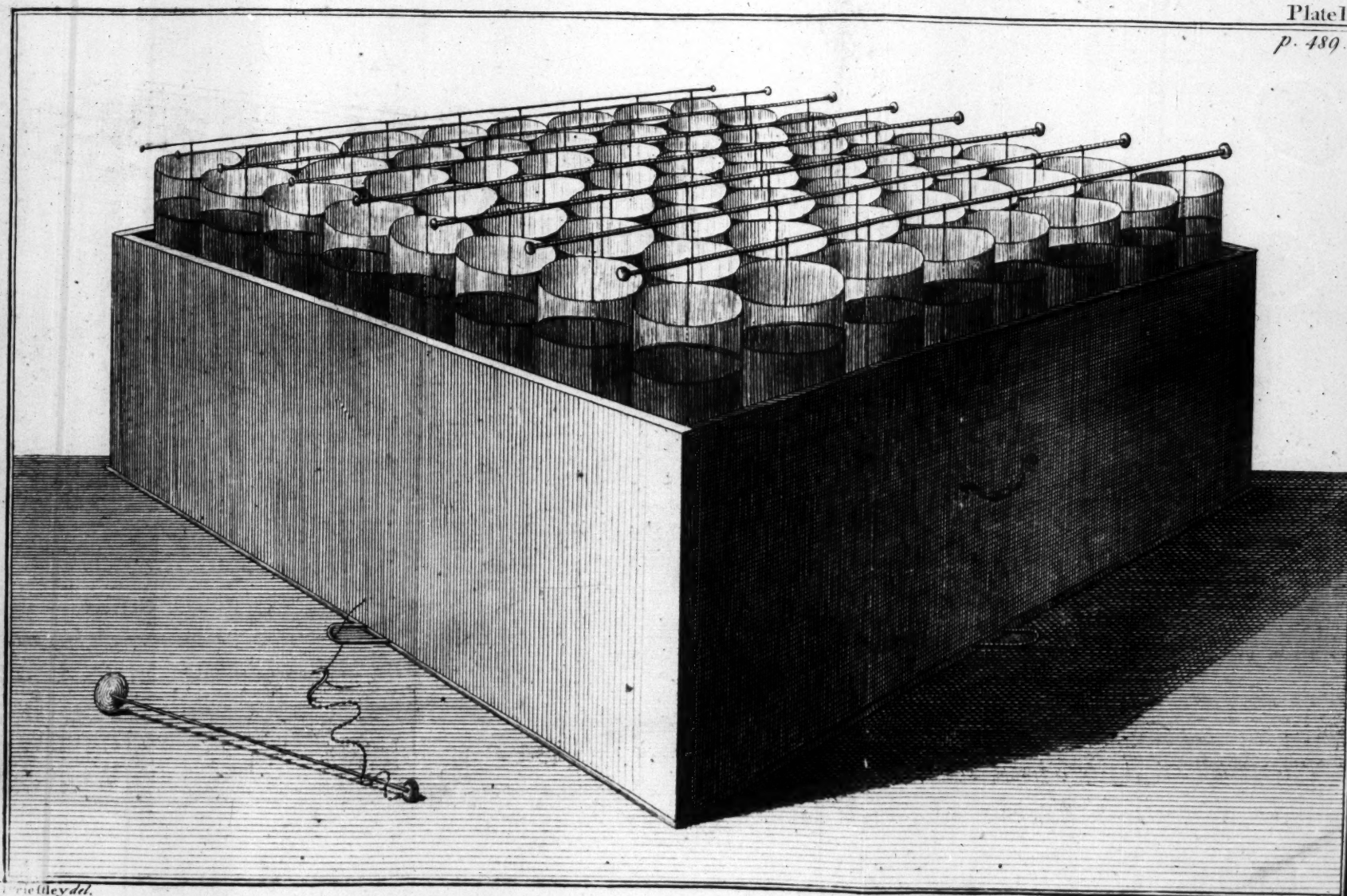
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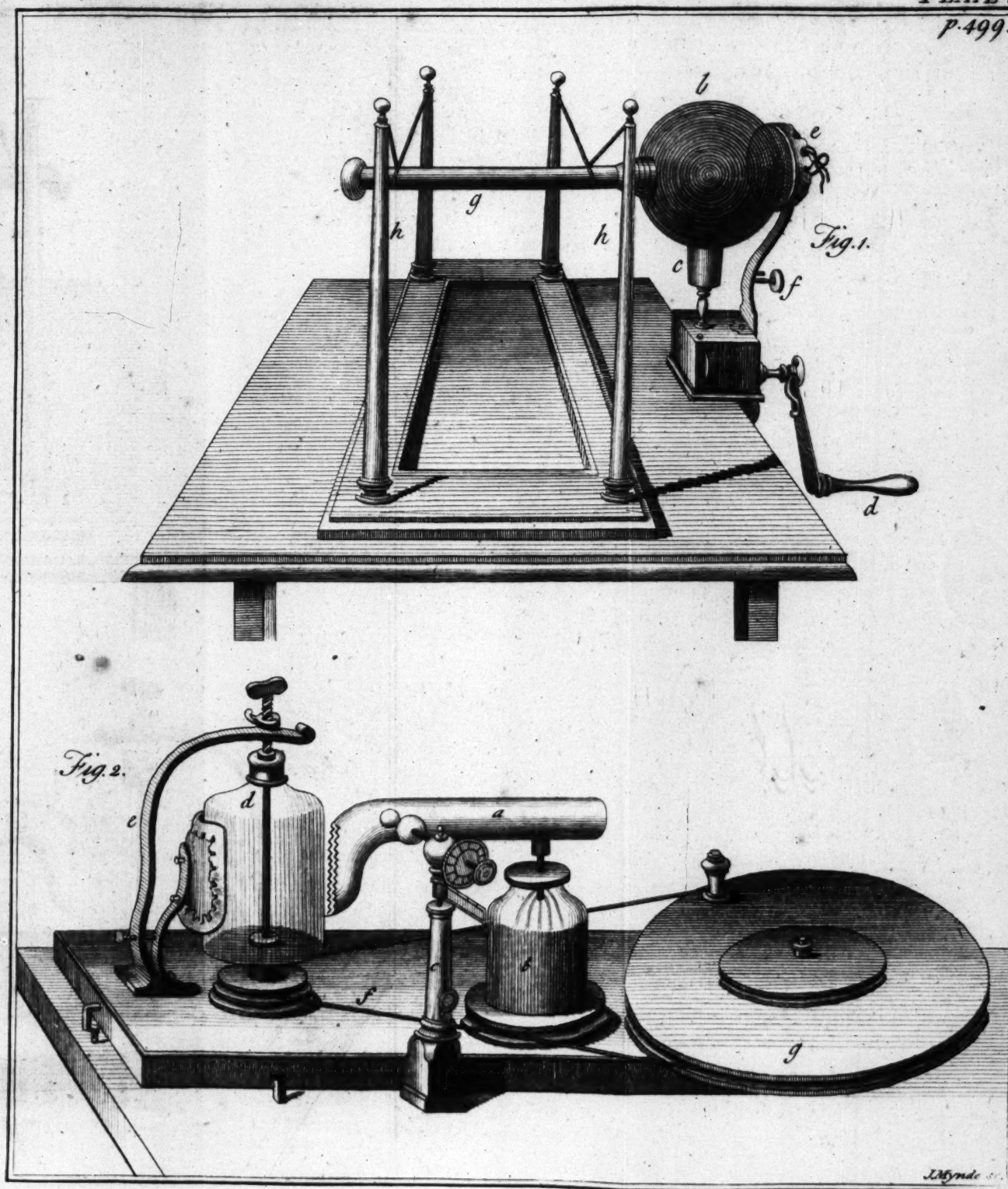
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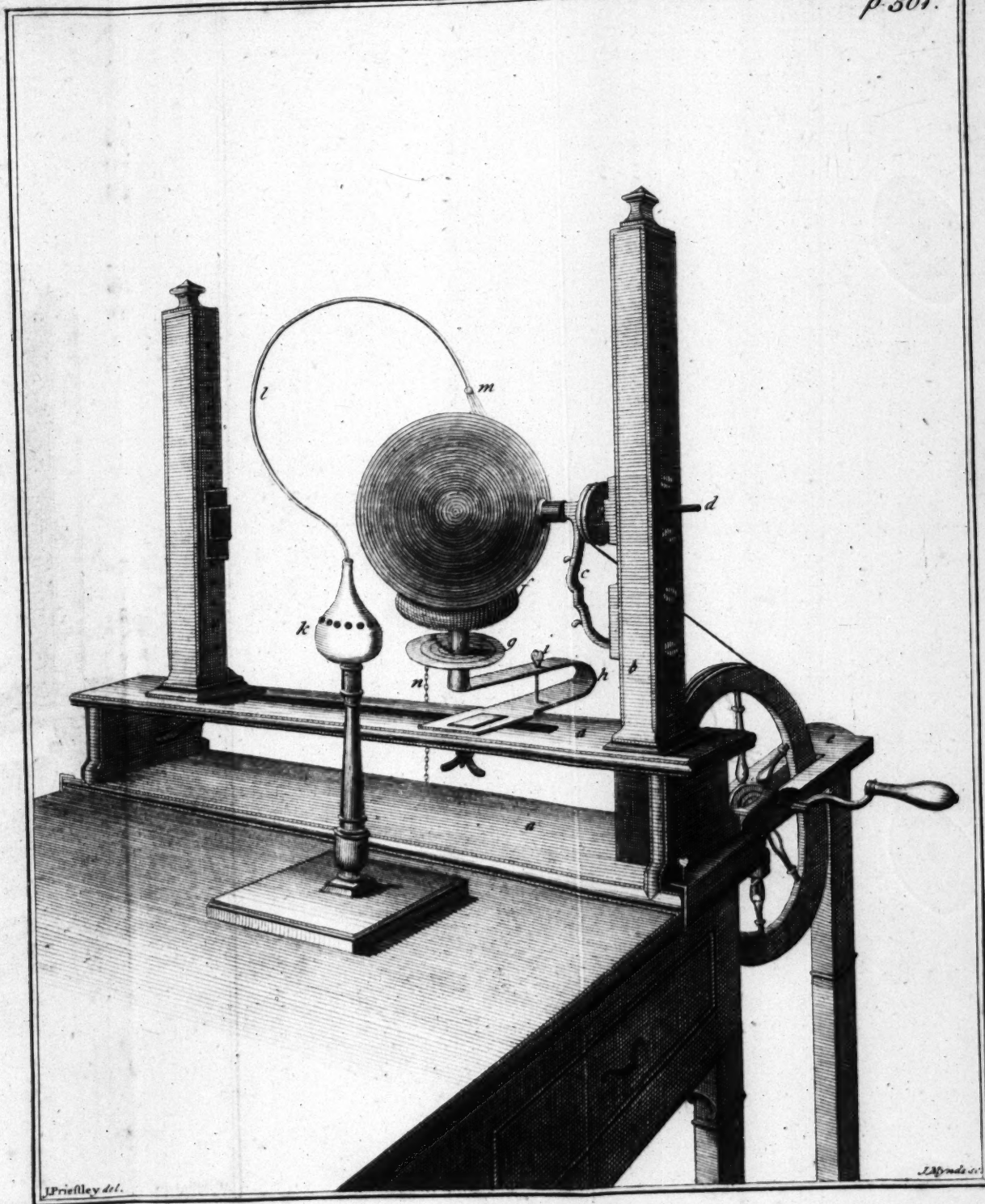


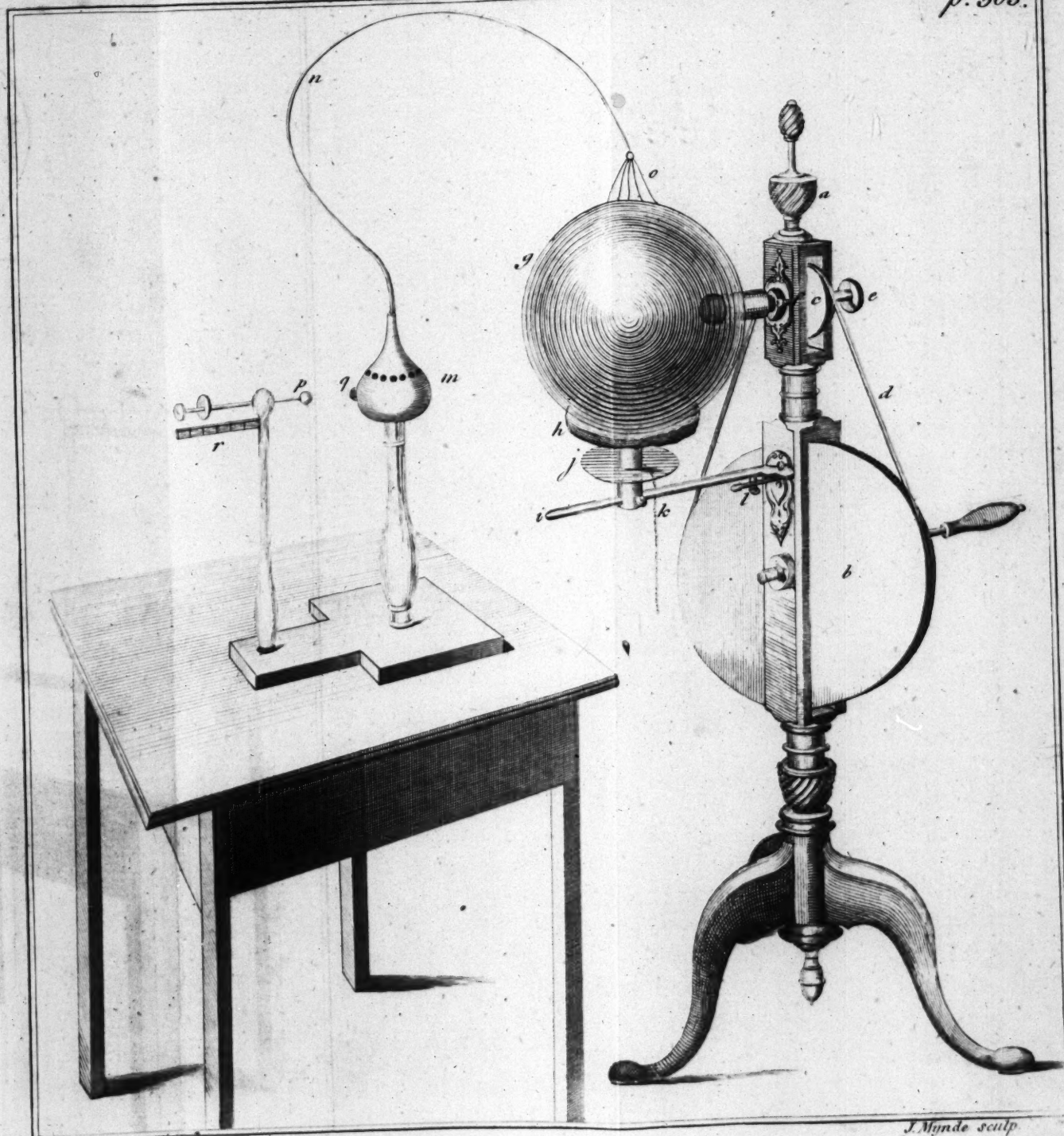


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